Blood

The liquid connective tissue that transports substances throughout the body

- Blood transports nutrients and oxygen to the cells and carries away the cell's CO_2 and other wastes
- Blood also contains cells and proteins that fight infections
- Blood is composed of plasma (a liquid) and the formed elements (the blood cells)

Figs 18.2 and 18.3

Plasma

The liquid part of the blood; It transports dissolved molecules

- The plasma is about 55% of the total blood volume
- Mostly water, with the following dissolved molecules:
  - Salts (ions/electrolytes)
    - √ Examples: Na^+, K^+, Ca^{2+}
  - Nutrients and monomers
    - √ Examples: Glucose, fatty acids, amino acids
  - Cellular wastes
    - √ Examples: CO_2, urea
  - Proteins
    - √ Examples: Albumin (a blood protein for osmotic balance and pH buffering), antibodies, and clotting proteins
  - Hormones

Figs 18.2 and 18.3; Table 18.3

Formed elements (blood cells)

The cells suspended in the plasma

- The blood cells are about 45% of the total blood volume
- There are three major blood cell types: Red blood cells, white blood cells, and platelets.
- Red blood cells (RBCs, erythrocytes) = Blood cells that carry O_2
  - √ Flat round cells with an indent on each face
  - √ No nucleus or other major organelles
  - √ RBCs are filled with the protein hemoglobin, which binds O_2
  - √ They are the most numerous of the formed elements
- White blood cells (WBCs, leukocytes) = Blood cells that fight infections and cancer
  - √ There are five white blood cell types
- Platelets = Tiny irregular shaped cells that involved in blood clotting

Figs 18.3, 18.5, 18.6, 18.7, and 18.13; Table 18.3

Formation of blood cells

All blood cells are formed from stem cells in the red marrow of bones

- Mostly in ribs, sternum, pelvis, and skull bones
- Blood cell formation is controlled by hormones
  - √ Erythropoietin (EPO) increases RBCs production
  - √ Cytokines and interleukins increase WBC prduction

Fig 18.4

Anemia

Weakness due to inability of blood to carry sufficient O_2

Possible causes of anemia:

- Lack of iron in diet
  - √ Hemoglobin uses iron to bind the oxygen it carries
- Loss of erythrocytes through bleeding
- Chemotherapy
- Hemolytic (bursting RBCs) diseases
  - √ Examples: Malaria, sickle cell anemia

Fig 18.9

Hemostasis

The series of events that stops blood from flowing out of a broken blood vessel

- Hemostasis begins with platelets binding to the exposed collagen in the connective tissue around the vessel

(1) Vasocontriction (constriction of the blood vessel) occurs to slow blood flow
- Vasoconstriction is caused by molecules secreted from the platelets bound to the collagen

(2) A platelet plug forms
- The platelets in the cut stick to the collagen and to each other

(3) Coagulation (formation of a solid clot that stops the bleeding and covers the break until the tissues are repaired)
- The blood clot is a web of fibrin protein with trapped RBCs and platelets

- Fibrin = A large sticky protein made by linking smaller fibrinogen proteins together

- Thrombin = The blood enzyme that links fibrinogen together to make fibrin

√ Thrombin is made from prothrombin (an inactive precursor)

√ Molecules secreted from torn cells and tissues activate a series of clotting factor proteins, which in turn activate prothrombin to become thrombin

- Serum = The liquid left in a blood sample after it has clotted (plasma without fibrinogen)

Fig 18.14

Disorders of hemostasis:

- Inability to stop bleeding
  - √ Causes: Hemophilia (genetic lack of a clotting factor), deficiency in vitamin K, low platelet count
- Thrombus = A clot that forms in an unbroken blood vessel
  - √ Embolus = Anything that can block a blood vessel, such as a dislodged thrombus that travels in the blood stream
  - √ Myocardial infarctions are usually caused by a thrombus blocking a coronary artery that is already partially blocked by plaque

Thrombolytic drugs

Medicines that dissolve a thrombus

- Given to patients to dissolve an existing thrombus (to treat a heart attack, stroke, or pulmonary embolism)

Anticoagulant (blood thinners)

Medicines that inhibit hemostasis

- Given to patients to prevent thrombus formation (to reduce the risk of heart attack or stroke)
- Examples: Coumadin, heparin, aspirin

Antigen

Molecules (usually proteins, carbohydrates, and lipids on the surface of a cell) that the immune system can interact with

- Foreign antigen = A molecule that does *not* occur naturally the body

  √ The immune system attacks cells that have foreign antigens using proteins called antibodies

- Self antigen = A molecule that does occur naturally in the body

  √ The immune system does not attack cells that have self antigens

Blood types (blood groups)

Different types of blood caused by different antigens on RBCs

- There are 3 major antigens that can be found on RBCs:

  √ A antigen , B antigen, and Rh antigen

- There are 8 possible blood types, based on which antigens are found on the person's RBCs*

  √ A+, A-, B+, B-, AB+, AB-, O+, or O-

  * O = Neither A nor B antigen is present
  * + = Rh antigen is present, - = No Rh antigen

Fig 18.17; Table 18.2

Blood transfusion

Giving blood to a patient

- Transfusion mismatch = Giving a patient a transfusion of blood that has a foreign RBC antigen to that patient (can be fatal)

  √ The RBCs with foreign antigen are lysed by the patient's antibodies

  √ The cellular debris clogs the patient's blood vessels

- Never give a patient blood cells that have a foreign RBC antigen to that patient

A method of finding safe blood types for transfusion to a patient

(1) Make a table of all 8 blood types

(2) Write the patient's blood type next to the table

(3) Below the patient's blood type, make a list of the antigens that are foreign to the patient

  √ These are all the antigens that the patient does **not** have

(4) On the blood type table, cross out any blood types that have any of the patient's foreign antigens

(5) The not-crossed out blood types are safe to give to the patient